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Starr Jordan, president of Stanford University. It was recommended that the following meeting be held in Minneapolis. All the affiliated societies will probably wish to go to Boston, and the meeting is likely to surpass in importance even the present meeting. In the following year the special societies whose membership is chiefly on the Atlantic seaboard will have an opportunity to meet separately. In order that the societies may have information in planning joint or separate meetings, the general committee voted that it looked with favor on convocation week meetings in Washington, Cleveland and Toronto, following those in Boston and Minneapolis. The council of the British Association has invited members of the association to attend the Winnipeg meeting next August, the officers as honorary members. In the following summer a meeting will probably be held in Honolulu.

SCIENCE TEACHING AS A CAREER¹

It is scarcely a serious exaggeration to say that the first thought regarding a teacher which comes to the minds of many estimable people is that of a person who, by virtue of a greater or less assumption of knowledge, is able to occupy a position in which he has frequent long vacations, and in the interim draws a comfortable salary for comparatively short working hours. Such, at least, is the conclusion which may apparently be drawn from the frequency with which these topics are introduced into conversations incident especially to the

making of new acquaintances. But these same persons would many times experience a tinge of regret if their sons should choose to adopt this career, and that not because they definitely believe it to be an unworthy or inadequate career, but because they understand very little about it. It is, however, not only true that this supposedly comfortable profession is not overcrowded, but there is evidence that there is a positive dearth of able young men who have both the aptitude and disposition to become teachers. It seems to me, therefore, fitting that we who are interested in the advancement of science should spend a few minutes in the consideration of the conditions which confront a young man who is disposed to become a teacher of science, since the maintenance of a corps of competent teachers is of no less interest to us all, practitioners as well as pedagogues, than are the subjects which they should teach, some of which have been ably discussed in recent addresses.

It is the more appropriate that this question should be considered at this time, since certain presumably authoritative data regarding the compensation of teachers have recently become available, and because the establishment of a section on Chemical Education on the part of the American Chemical Society, the first session of which follows this address, indicates an awakening interest in all that pertains to the education of the chemist and chemical engineer, among which the question of the best means to maintain our supply of capable teachers must assume an important place.

What I shall say will apply doubtless most closely to teachers of chemical science in institutions of college grade, because the conditions under which they labor are most familiar to me; but much that may be said of these teachers is true of those in other sciences which stand in a relation to the arts similar to that of chemistry. A

¹Address delivered by the retiring chairman of Section C of the American Association for the Advancement of Science, at Baltimore, December, 1908.

great deal has been written on this and similar topics, and I can claim very little originality in the thoughts which follow. I present them in the hope that they may arouse in you, parents, employers, practitioners and teachers, an increased interest in the general welfare of those to whom the teaching of science is entrusted.

It may first be asked, What ground exists for the assumption that there is a present or prospective lack of science teachers? It seems to me that this is indicated by the increasing difficulty which is reported from various institutions and from various departments as having been experienced in filling their instructing corps with the best type of men. I know this to be true in chemistry from my own experience, and from the marked increase in the number of applications for assistants which have come to me from all parts of the country. Unless many of us misjudge the trend of the times, the increasing pressure of competition, making necessary the improvement of old and the devising of new means for the utilization of by-products and waste materials, the greater refinement of products without added cost, demanded by the consumer, and the awakening of the country to the necessity of husbanding its natural resources, all tend to place the chemist and chemical engineer in the forefront of industrial activity, and to make those professions increasingly attractive to our young men, as affording unexcelled opportunities for productive work in a field which at present is not overcrowded. If, at the same time, it is possible by missionary effort to dispel the well-established notion among fond parents that chemistry, pure or applied, is synonymous with explosions and impaired health—an opinion which lacks a statistical basis—the number of young men entering the profession will doubtless increase, but it may fairly be questioned whether what

may be designated as the “call of the practical” will not prove increasingly alluring, and our difficulties in retaining able men of the type which we desire to enlist in the service of our institutions, become more and more serious.

Let us face this situation squarely and ask, What is it that makes this “call of the practical” so enticing to ambitious, thoughtful young men who are conscious of their ability to get results, or, perhaps, merely hopeful of a fair measure of success in what they undertake? Money and opportunity are obviously the influential factors; and in the best type of men the latter is likely to be given the greater weight in the selection of a life work. Let us look at these a bit more closely. No one acquainted with existing conditions, if appealed to for advice by a young man facing his choice of a career, would fail to point out to him the probable financial sacrifice involved in the selection of the work of a teacher. Indeed, this is so serious a question that in the case of a young man who may be without financial resources other than his earnings, but is tactful in his dealings with his fellowmen, of high scholarship, and with ability to think independently—just the man who is needed in our corps of teachers—one may well pause before uttering decisive words of counsel which will almost certainly be of great influence in determining the material prosperity of his later life; of greater influence, I sometimes fear, than our knowledge of the past or our prescience really warrants.

How great, in reality, is the financial sacrifice involved in a decision to enter the teaching profession? Data regarding the compensation of teachers in institutions of college grade have recently been made public by the Carnegie Foundation for the Advancement of Teaching in its Bulletin Number Two, on “The Financial Status of

the Professor in America and Germany." In view of the unusual opportunity possessed by the Foundation for the gathering of authoritative data, the figures presented merit attention. No distinctions are made between teachers of science and those in other departments, but, considering salaries only, it does not appear that marked differences exist, and it is probable that the average salaries as there given may be taken as being also representative of those of science teachers. Some of the more relevant statements are as follows: Considering one hundred and three institutions in the United States and Canada which have an annual salary budget of \$45,000 and over, the average salary of a full professorship ranges from \$1,350 to \$4,788. Only eight institutions report an average below \$1,800, and only nine an average above \$3,500. Half of these institutions average less than \$2,200. Taking them all into account, the average appears to be close to \$2,500, but there are more below than above this figure. Individual salaries apparently vary from about \$500 to \$8,000, both being, however, exceptional.

The average salary of an assistant professor is about \$1,600 (half of the institutions pay less than \$1,500); and the salary for the grade of instructor averages a little over \$1,000.

Closely linked with the amount of the salaries paid is the question of the period in the teacher's life when the various amounts may be expected to be obtainable. On this point the statement in the bulletin, based on the available data, is this:

A man acceptable to these institutions for a position worth \$1,250 will be on an average 28 years old; a man appointed to a position worth \$1,750 will be on an average 31 years old when appointed to it; one appointed to a position worth \$2,250 will be on an average 33 years old; one appointed to a position worth \$2,500 or over will be on an average 34 years old.

And elsewhere it is stated that appointments to positions carrying salaries of \$3,000 and upward are not usually made before at least 35 to 39 years of life have been completed.

It is interesting to note in passing that the data from fifty-four additional institutions having salary budgets below \$45,000 annually, indicate that the average salary of a full professorship in them is \$1,800, and that this is reached by men when about 33 years of age.

The average salary of an assistant approximates \$500. It is, however, properly emphasized that the period of service as assistant is essentially one of apprenticeship, during which the incumbent gains much more than is represented by the monthly salary check. Indeed, it is my own conviction that a year of service of this character is, to a right-minded young man, nearly the equivalent of a year of post-graduate study, and affords an experience which is valuable, whether the career ultimately chosen is that of a teacher, or lies in the commercial field.

In order to determine whether, or by approximately how much, the teacher is at a disadvantage as compared with others of equal age and training in other occupations, information was collected by the Carnegie Foundation which is to the effect that the average competent lawyer and competent engineer, after being out of the professional school about eight or ten years (thus approximating the age at which a full professorship with an average salary of \$2,500 is attained) would be earning in New York between four and five thousand dollars a year. A physician might earn somewhat more. The average professor's salary at Columbia University is \$4,289, while that of the College of the City of New York is \$4,788; but, for special reasons, these averages are said to be abnormal. The corresponding figure for Stevens Institute

of Technology is \$3,200, and that for Brooklyn Polytechnic Institute is \$2,783. It appears, then, that the average college professor at 34 is receiving a less return than his contemporary in other professions by perhaps \$1,000 per year, although there may well be individual instances in which there is little disparity. But this is not the main issue; for, as is pointed out in the bulletin referred to, it is at this point that the divergence in the financial rewards begins to increase rapidly. The salary of the full professorship, reached at 34, represents nearly the limit of the earning power of the incumbent if, as is so often true in our institutions, his entire energies are consumed in his institutional service, unless perchance he occupies some position carrying with it special administrative responsibilities. His colleague without the walls of the college has, on the other hand, also just entered upon his most productive period, and may reasonably hope to see his income increase into the tens of thousands, permitting him to maintain a comfortable home and affording him means to meet the growing expenses incident to the education of his children. So far, then, as young men are influenced by the maximum financial rewards and prizes attainable, it must frankly be admitted that, at present, the teaching profession is at a disadvantage.

But I am personally disposed to believe that such difficulties as exist in securing and holding able men as teachers of science are less the result of the comparatively small maximum returns which may be expected when the final stage in professional promotion has been reached, than because of the depressing conditions which confront them during the long period which now elapses between the attainment of salaries of \$800 to \$1,000, and a salary of \$2,000, a period which, in the larger institutions is probably rather more than six

years. The young teacher's apprenticeship as assistant or junior instructor is over, and he is anxious to feel that his long period of study and development is bringing him an adequate return, and he hears his classmates tell of bridges built, factories started, laurels won, and salaries raised—sometimes with an all-too-thinly veiled suggestion that he has chosen the less worthy rôle—and he longs to join those who can boast of material successes. To this is often added the proper desire for a home of his own. Or perhaps the home has been established, when there must be a struggle to provide those comforts (not luxuries in an extravagant sense), which his temperament and training lead him to desire, which his institution and his community tacitly expect of him, and which above all, would make of him a man of growing refinement such as we are increasingly in need of in our teaching ranks. Helpful and necessary as it is to increase the salaries of the higher paid professional positions as soon as this is possible, I believe that there is a still more urgent need that the salaries of the junior grades should be earlier lifted to a point at which the strain of anxiety is removed and moderate comfort and congenial surroundings are made possible. This is, of course, mainly true of our larger institutions, or those situated in communities where the cost of living is now so sadly out of proportion to the amounts on the salary lists, but it may be questioned whether the ratio of income to outgo is essentially better in smaller institutions and places. I believe that this is a matter which all of the college authorities should consider in order that this period may prove less repellent and that the rounding out of the non-professional side of the science teacher, which is often so large a factor in his success, may not be postponed until many of his best years have been spent in a de-

pressing effort to accomplish the impossible. A young teacher is fortunate if, during this time, he is not obliged to suppress his desire for research, acquired by years of training, in order to avail himself of opportunities to add something to his meager income.

Data concerning the salaries paid to teachers of science in public schools below college grade are to be found in the Report of the Committee of the National Educational Association on Salaries, Tenure and Pensions of Public School Teachers in the United States, dated July, 1905. From the extensive tables there given it would appear that the average maximum salary paid to male teachers in cities or towns having from 8,000 to 12,000 inhabitants is about \$800 per year, in cities numbering 10,000 to 15,000 about \$1,000, in those of 15,000 to 30,000 population about \$1,200, in cities of 30,000 to 75,000 inhabitants about \$1,500, and so on up to cities of 200,000 inhabitants or over, when the maximum is about \$2,000. The highest salaries are paid in New York, amounting probably to \$3,500 for those having positions of sub-masters or heads of departments. The opinion has been expressed to me by well-informed science teachers that the salaries paid such teachers do not differ essentially from the average salaries named above, but that salaries paid by private schools may be in general somewhat higher than the figures named. Here, again, it seems to me that those in authority should realize that more than a bare living wage must be provided for the younger teachers if the best results are to be obtained, and my own observations lead me to express a further belief that the efficiency of these teachers is much less than it might well be because of inadequate assistance—a condition of affairs which makes it necessary for them to devote time which should be spent in instruction to the mere distribution of supplies. ~~It is not~~ much; almost everything indeed, if

expected that these and other related topics will be considered in detail at some early session of the Education Section of the American Chemical Society. I will not, therefore, dwell longer upon them now.

It has already been said that the opportunity for accomplishment which the technical field opens before the young man is alluring to a high degree, and, although I have thought it wise to dwell first upon the financial aspects of a teacher's career, I am far from thinking that the avoidance or abandonment of that career by those who have shown themselves fitted to enter upon it, is mainly due to anything which could be described as greed or avarice. What, indeed, can be better worth undertaking than the development of a new industrial process, very likely the product of one's own careful thought; to watch it grow from a thing of the beaker and test-tube in the laboratory to the successful operating plant, where tons are substituted for grams? Where are there problems better worth attacking than the careful investigation of sources of difficulty in existing processes, with the sense of satisfaction and triumph which accompanies their ultimate rejuvenation? And to whom does there come wider opportunity for honorable service and tangible reward than to one who, through leadership and the helpful guidance of a corps of trained investigators such as are found in the research laboratories of some of our larger manufacturing organizations, has at once the privilege of extending the boundaries of his chosen science and, by improving or cheapening production, to increase industrial efficiency, which in many instances means ultimate benefit for us all. The joy of material accomplishment belongs to the worker in each of these fields.

What is there, then, left to be said in behalf of science teaching as a career? ~~It is not~~ much; almost everything indeed, if

we are speaking to the man whose aptitude lies in that field. Let us turn again for a moment to its bug-bear, the financial side, which will then be finally dismissed. Conditions are not just as we, the teachers, or the college authorities, would desire them to be, but there are signs of improvement, which this Association and the Chemical Society can promote. But after all, the teacher's patience is ultimately rewarded by a monetary return which for the really able man (who alone would receive the higher rewards in the commercial field) is not inconsiderable. Moreover, his tenure of office is in general secure during good behavior, and it is no small comfort to feel that the salary check, though of moderate amount, will appear regularly during those times of stress when our supposedly more fortunate brothers are growing grey with anxiety regarding the next turn of the market.

The science teacher of to-day is, moreover, usually something of a specialist and expert, and I believe that it is his duty, as well as his privilege, to make himself acquainted with the applications of his specialized knowledge in the technical field, and so far as it may be done without violence to duties already assumed, to avail himself of opportunities for expert service, especially where these involve an impartial treatment of problems of some importance. Service of this sort well-performed is highly remunerative, and serves at once to broaden the teacher and to contribute to the comfort of those dependent upon him; and in individual instances, to relieve much of the disparity between the income of the teacher and the technician. In this respect the science teacher possesses a distinct advantage over his brother in the academic field, and the engineer or chemist an advantage over the specialist in a descriptive science, such as astronomy.

The effect of the establishment of the Carnegie Foundation for the Advancement of Teaching must not be overlooked. Its generous endowment provides, as many of you know, retiring pensions which may be claimed as of right by teachers who have served in a professorial capacity for twenty-five years, or who have reached the age of sixty-five, with a record of fifteen years of professorial work. Provision is also made for the family of a teacher who at the time of his death was entitled to a pension. It may, however, be noted that at present no general provision is made for the same class of junior professors referred to above as struggling with meager salaries. It would undoubtedly prove exceedingly helpful, both by relieving anxiety and by making the teaching profession more attractive, if it were ultimately found practicable to provide widows' pensions in the case of the death of junior teachers who have not completed the prescribed twenty-five years of service. It is apparently true, however, that the trustees of the Foundation would even now consider individual cases of need, on their merits.

But what of the opportunities, the privileges of the teacher? They are almost limitless. Is there drudgery? Yes; but what vocation is without it? Does he have to repeat the same story year after year? In part, yes; but it never need be wholly the same and the audience is never twice the same. And the long vacations? They are available, if they are needed (and then they are blessed indeed), but they are seldom periods of continuous idleness, but are rather one of the great opportunities which come to the teacher, as to few others who are under obligations to render definite services. To the progressive, enthusiastic teacher these should be periods of growth; a chance for uninterrupted thought regarding his specialty or his work; a chance

to record his thoughts for the benefit of others, if he is so minded; a chance for research work, or, perhaps, a chance to follow some hobby or to travel. In short, these vacation days bring with them a necessary relief from the exhaustion attendant upon a constant effort to adapt oneself to the needs of those about him, which, as we shall see, is a necessary part of a teacher's life, and they afford him an opportunity for freedom of choice in his pursuits which is often prized quite as much in connection with his avocation as with his vocation. But this freedom of choice is not confined to vacation days. It constitutes one of the great attractions of the teacher's life. Not only may he choose freely within his specialty in selecting a congenial subject for investigation, thought or exposition, but he may even change his specialty and qualify as an expert in a new field without loss of prestige, and often without financial inconvenience. With the recognition of the fact that a teacher accomplishes most when allowed to inject his individuality into his methods of instruction, wise administrators will try to exercise control over the individual only so far as is absolutely necessary to preserve general unity of purpose and policy in a given institution, holding each teacher responsible for results in his own classes. With this freedom to select his own methods, it is hardly possible that the work of a thoughtful teacher should become irksome because of repetition, especially when it is remembered that his pupils present an infinite variety of types, each type with its own personal equation to be studied. The fact that wholly ideal conditions as to "academic freedom"—whatever that may mean—have not yet been reached is, I think, not a reason for depression on the part of the teacher, and is still less a cause for hesitation on the part of one desiring to enter the profession.

There is to-day surely at least as great freedom as in any other profession with equal obligations; and the outlook for the future is hopeful.

Some young men are, I believe, deterred from considering teaching as a profession because they regard the teacher as an essentially unpractical man—a man who is, to be sure, generally respected for what he is supposed to know, and is accorded social recognition, but who, nevertheless, may, in clothing himself for his daily tasks find difficulty in distinguishing his right shoe from his left, or may appear on the most formal social occasion without some essential article of wearing apparel, because of mental preoccupation. Such men exist, but they are typical of a limited number of teachers only. They are, as a rule, investigators and intense specialists who should gather around themselves a group of advanced students sufficiently mature to largely forget personal peculiarities in the enthusiasm which they have for the work in hand. The rank and file of teachers are not such as these, and it is well that this is so.

It is recognized that every earnest teacher should either carry on some research work of his own, or be able to be in contact with those who are conducting such work, in order to keep himself acquainted with the progress of his science, and here, again, he may choose between an abstract problem in science and one with utilitarian bearings. He should not, in my opinion, lose caste to any degree if he chooses the latter, provided the problem is worthy of the time and energy which its solution demands. Every teacher should thus be something of an investigator, but not every gifted investigator should, in my opinion, be entrusted with the care of undergraduate instruction. By this I mean that the teacher, as is pointed out in Professor George H.

Palmer's admirable essay on "The Ideal Teacher," must be primarily one who has an aptitude and a passion for making scholars of others, rather than merely becoming one himself. Many learned men think too rapidly and keenly to be able to adapt themselves to the younger students. Professor Palmer justly puts "the aptitude for vicariousness" first in his characteristics of the ideal teacher, for it is only by constantly putting oneself in the place of the "average man" of the class that the teacher can evolve genuinely helpful methods of presentation, and enable his students to take such possession of the knowledge imparted that it adds to their power rather than to their collection of impedimenta. The teacher must not only, as some one has aptly said, have his knowledge in "contagious form," but he must study methods for spreading the contagion; for the sterilizing outfit on the side of the student is all too often wonderfully efficient in its working.

I desire to give expression to a conviction that some influence—whether the increased pressure of the times in which we live, or the alleged materialistic tendencies of these times, or the increased absorption of the science teacher in his specialty, it is difficult to determine—some influence, I say—seems to be operating to diminish the interest on the part of younger teachers of science in breadth of culture. In technical institutions particularly, it is vital to the best results that the younger students especially should be made to appreciate that even the grade of professional position which they will ultimately fill will depend upon their ability to view their own profession broadly, upon their ability to take their proper part in community life, and upon their ability to have an avocation which will relieve the tension of uninterrupted and often anxious thought along

one line. Mere preaching will not accomplish this end; but men who are themselves real examples of the enrichment which comes into life from breadth of interests can by simple contact do an untold amount of good—and that, too, when they themselves least suspect it. We need more men of this type, and I believe we can get more when it is possible to improve the living conditions of the junior members of the instructing staff, so that there is somewhat more time for that personal development which is too often postponed now, because of the exigencies of the early years of teaching.

And now we come to the crowning joy of the teacher, the joy of helpfulness. Fortunately, he may often also experience the delights of conquest known to the investigator; but, as a teacher, his keenest satisfaction must be found in the contact with young men, and in the consciousness that his efforts have made some dark places less confusing and obscure, and that life is to have more and a better meaning for some men because of his association with them. He must, as Professor Palmer points out, "be willing to be forgotten," in that he must not set a desire for popular approval in the place of real helpfulness, and, unless he courts disappointments, he must not expect an expression of gratitude or even of appreciation on the part of the few who take any notice of him which is in any way commensurate with the effort which he knows that he has put out in their behalf. But the sympathetic, helpful, well-informed teacher may expect to make warm and lasting friends in a larger measure than almost any one else. I believe that any teacher, whether of junior, senior or advanced students, who does not so far gain the good will of his pupils that they feel that his relation to each is in some measure personal rather than merely professional,

falls short of the best attainable. The scholarly teacher, with the genuine passion for making scholars, is fortunate indeed if he combines with it such broad sympathy and good sense that his pupils will come to him for advice on homely, everyday questions; for the influence thus gained doubtless reaches farther than we can possibly know. For the teacher of science, who more than his colleagues in other departments of learning, has the opportunity to lead the thoughts of his pupils by an occasional judicious word toward a better appreciation of the orderliness of that which we do know, and of the vastness of that which is beyond our ken, the privileges as well as the responsibilities are especially great.

The teacher's career is one of some sacrifice. Let us admit it, and admit also that it may not be undertaken by those who have not aptitude and liking for it, for these are both indispensable to success. But let us remember, too, that it is truly a noble calling, accorded a dignified standing in our communities; that it means for those who enter upon it an association with scholars and a share in those affairs which we believe make for advancement of our race; that its rewards in the way of recognition among scholars, and in the occasional spontaneous expressions of appreciation on the part of pupils, as well as in the lasting friendships formed, are not unworthy to be placed beside the more striking and tangible financial successes of other professions. Let us recall that the advancement of our sciences must always depend in a large measure upon the maintenance of a high type of teacher, as well as of teaching, for which we need able, broad-minded men, not those who are merely indisposed to adopt some other profession; and to this end let us foster an interest in the teacher's career on the part of more of those to whom those

traits of mind and character which make for success in this honorable profession have been freely given.

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*RECENT RESEARCHES ON THE DETERMINATION AND HEREDITY OF SEX*¹

I. STATEMENT OF THE PROBLEM

DESPITE certain technical difficulties, the subject of sex-production has seemed to me to be an appropriate theme for this occasion for two reasons. The phenomenon of sex is so nearly a universal one that it may be assumed to make some appeal to the interest of biologists in every field of inquiry. Secondly, although the physiological meaning of sex still remains in many respects enigmatical, it may fairly be said that substantial advances in the analysis of the mechanism of sex-production are being made by experimental and cytological research. It is not my intention to consider at this time the possible significance of sexual reproduction or the physiological and cytological problems involved in the phenomena of fertilization. My discussion will be confined mainly to the more recent of the researches that have thrown light on the questions of sex-determination and sex-heredity. Does sex arise, as was so long believed, as a response of the developing organism to external stimuli? Or is it automatically ordered by internal factors, and if so, what is their nature?

It will be well at the outset to remove any possible obscurity from our definition of the problem. Every form of heredity—and sex-production, broadly speaking, is unquestionably a phenomenon of heredity—is in one sense a response of the developing organism to external stimuli. The

¹ Address of the vice-president and chairman of Section F—Zoology—of the American Association for the Advancement of Science, Baltimore, 1908.